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EAST SLOPES (ALBERTA) WATERSHED RESEARCH PROGRAM

CO-ORDINATOR'S SPECIAL REPORT

TO STEERING COMMITTEE, 1966

by

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NOT FOR PUBLICATION

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INTRODUCTION

The first full work year in the watershed research program was 1963. Actual research implementation has had three full years and one part year, during which various networks, surveys and compilations have been begun, two experimental watersheds set up, and some individual studies undertaken. Project initiation to provide a reliable foundation for continuing, intensified research has been emphasized.

This initial phase is nearing completion; concentration will soon be upon deep sustained research in priority topics. A steady flow of scientific contributions, lacking hitherto, will result.

The program is one of regional research in watershed management. It has two main objectives: (1) to develop proven land management methods, in the Saskatchewan River headwaters, to maintain or improve water supplies and (2) to further understanding in hydrology. Success in the first is likely to be somewhat dependent upon progress in the second.

This report attempts to show how the program stands and in which directions it should develop. Only a very broad view is taken. First, the different types of investigations are summarized. Current projects are then briefly reviewed and their future development projected. Finally, anticipated areas of study innovation are very sketchily outlined. In this, as throughout this report, views presented are a personal opinion only.

BROAD TYPES OF INVESTIGATIONS UNDERWAY, AND THEIR

GENERAL FUTURE DEVELOPMENT

Networks

These have an important function. Expansion of climatic and snow course networks is underway. The hydrometric network is being rapidly expanded, and will provide new and valuable data from small and medium-sized drainages, as well as large basins. Data eventually obtained by groundwater inventory will be valuable to research planning, particularly if artificial recharge possibilities are found.

Lack of any real sediment network is a major defect, making water quality research needs difficult to evaluate thoroughly. A much intensified sediment network program is needed.

The chemical water quality network should continue on a sufficiently intensive basis to establish a satisfactory "bench mark". If large changes in land use, including industrial development, occur these data will be priceless.

Broad surveys, inventories and data compilations

These broad studies also furnish information on the whole headwaters. They help define variability in factors such as soils, surficial deposits, forest cover and watershed characteristics.

Surficial deposits and reconnaissance soils survey will eventually be complete. Forest survey is already done. Climatic data are compiled and hydrometric data are being analyzed. Upstream water storage capacity information should be sought from Alberta sources, to aid research planning. Existing and proposed erosion damage survey data collected by management agencies should be sought, along with any watershed analysis data being collected. These are of considerable value to research. Finally, the overall Nelson River Basin study will, upon completion, furnish a broad and valuable perspective.

No major new surveys are presently envisaged, assuming damage survey and watershed analysis information is made available to researchers.

Gauged basins

Two experimental basins (Marmet Creek, Streeter Basins) are in operation; a third is being selected.

Gauged basins have two purposes: (1) calibration, followed by application of treatment experiment(s), and (2) provision of information on small basin hydrology, and other basic hydrologic factors. In any incompatibility, the first has primacy.

In treatment experiment aspects, the experiment carried out in a calibrated basin is the "integrator" of many "companion studies". It has little merit in their absence.

In basic hydrology aspects, much attention is nowadays focused upon development of hydrologic models. Such work is demanding, but our research group possesses most necessary model-building skills. The research group should initiate studies of holistic model building. Outside aid should be sought, as needed, from government agencies or suitably equipped universities. Our small watershed data should be available to national or international groups attempting formulation of more generalized conceptual models.

Three highly instrumented basins seem sufficient. Other basins required will be of different concept. These should be minimally instrumented, serving eventually to extend results from the original basins. They are termed "auxiliary" basins. Needs for "auxiliary" basins should be analyzed and such basins instrumented, as necessary broad survey data become available.

No basin for alpine snowpack manipulation is recommended, alpine snow research being low in priority and manipulation potentiality.

Soil moisture instrumentation is an operational, technical and financial problem requiring solution in our gauged basins.

Initial and periodic analysis and interpretation of experimental basin data is essential. This must be done by the research group themselves, for technical efficiency and for their scientific growth. This function may be compromised by inadequate budgeting of research staff time.

Finally, a danger exists in unrealistic pressure for early implementation of treatment experiments. These must await a sufficiently accurate calibration, and an adequate base of knowledge, built up by companion studies.

Companion (plot) studies

Such work is already underway to some extent. Work must be greatly intensified, as soon as: (1) instrumentation programs in gauged watersheds are completed, and (2) more professional and research support staff are available.

These investigations usually seek to develop insight into hydrologic processes, for improved design of treatment experiments. Otherwise expressed, treatment experiment results can be predicted prior to treatment, and the prediction hypothesis tested. Thus companion studies: (1) provide badly needed basic knowledge of hydrologic processes, (2) furnish qualitative management guidelines, along with a reliable base for design of treatment experiments, (3) permit highly desirable, greatly increased refinement in treatment experiment hypotheses, and (4) provide physical reasoning and quantitative data for useful conceptual models.

RESEARCH UNDERWAY, CURRENT STATUS AND FUTURE DEVELOPMENT

Hydrology of subalpine spruce-fir forests

Subalpine spruce-fir forest, at lower elevations, is under management. Research is required into: (1) hydrologic effects of present cover removal (2) means of obtaining optimal hydrologic effects through forest manipulation (3) hydrology of "subalpine spruce-fir basins" (4) means of manipulating cover in the high elevation, non-commercial forest zone.

Current status

Marmot Creek Basin is designed to help attain these research needs. Its instrumentation and inventory are well advanced. No analysis of accumulated data has been made but is planned. Continual data re-analysis should be carried out in future. Subalpine spruce-fir hydrology research objectives are also being approached by supporting or companion studies.

Initial priority is given, in addition to the basin itself, to qualitative management guidelines. In water yield aspects, the primary approach is study of snow accumulation and melt in cutover and uncut forest areas. A partial base for rapid assessment of present cutting practice effects will result.

Two approaches have been taken to water quality problems. The first is erosion hazard study of pertinent surficial deposits, providing an improved base for "preventive" forest management. The second approach is by model logging operation, to determine the adequacy of logging and extraction techniques for water quality control, developed elsewhere. This will show whether local research is needed. It is difficult to overstress the importance of this project. A work-study component may be added, if cost is important.

Future development

Initial priority (short term) should continue to be given to qualitative management guidelines.

Major effort should be in continuing research into snow accumulation and melt. Designed cuts of varying shape, size and orientation should be tested. These also provide good research areas for snow hydrology and meteorology research. Silvicultural-autecological research in forest regeneration, and (possibly) evaluation of cutting effects on forage production should be encouraged in conjunction.

Major orientation of continuing research (long term) should be towards snow hydrology. Research into consumptive use is also desirable, though not so much as in lodgepole pine forests. There should also be expanded research into soil water.

Research will be required into the "representativeness" of Marmot Creek Basin, approachable initially by physiographic analyses and "potential insolation", dealing with a large population of spruce-fir basins. A totally distinct population of basins supporting foothills spruce-fir forest is believed to exist in the north of the headwaters. This research will help answer this question.

As time progresses, research will extend into high elevation, non-commercial forest, eventually to be concentrated there. This research should again deal primarily with forest-snow interactions. "Auxiliary" watersheds seem highly pertinent to Marmot Creek Basin.

Hydrology of montane aspen forest and associated grasslands

Research is needed, in essence, to furnish a base enabling land managers to decide whether forest clearance practices should be extended to public lands. Hydrologic effects of clearance only partially answer this; considerations of aesthetics, recreation, range management and wildlife management also enter. Water yield increase potentialities are considered relatively slight.

Current status

Streeter Basin helps provide a solution. Aside from groundwater and soil moisture, its instrumentation is virtually complete. Comprehensive data analysis should be carried out in 1967 and repeated continuously thereafter.

Again, a combination of gauged basin research and companion studies is utilized. Priority is given to studies pertaining to potential deterioration of water quality. Broad assessment of infiltration rates and capacities is the initial approach, comparing different vegetation types.

Basic studies of plant ecology and soils help provide a working base for hydrologic studies and for range management guidelines. Burrowing small mammals are also studied.

Future development

Priority should continue to be given to erosion hazard and sedimentation. Infiltration studies should be expanded into artificially cleared areas of different ages. Reconnaissance evaluation of soil movement following forest clearance should be carried out, to evaluate the need for (or scale of) runoff-sedimentation plot research. Small mammals studies should be extended into cleared areas and their actual effect on soil movement established.

A major effort is required into the potential effect of large scale forest clearance upon big game (deer and elk) populations. This is critically important.

Basic soils and vegetation studies should continue, in even closer integration with hydrologic studies. If erosion hazard proves a major problem, these and current hydrologic soils classification, will be especially pertinent. In such circumstances, evaluation of methods of forest clearance will assume greatly increased importance.

Consumptive use is a minor component of this project but should receive limited study, largely by soil moisture budgets. Streeter Basin is a promising location for research into sampling requirements for soil moisture evaluation on experimental watersheds. Such studies might be initiated, but this depends on national needs in such research. The "representativeness" of Streeter Basin should be examined. No "auxiliary" basins are believed necessary.

This study has lower priority than other major projects. Consequently, some research effort may be diverted in the future. Other rangelands, for example, require evaluation in water quality-sedimentation.

Recreation is important in this montane zone. Recreation research (other than effects of recreation pressures upon hydrology) should be approached by professional services contract or by extra-mural grant.

Hydrology of lodgepole pine forests

Forests composed predominantly of lodgepole pine occupy much of the forest reserves. Little commercial exploitation is underway, but a major pulp operation utilizing them seems highly likely in the future. Research is needed into: (1) hydrologic characteristics of lodgepole pine cover (2) means of obtaining optimal hydrologic effects by forest manipulation (3) hydrology of "lodgepole pine watersheds".

Current status

A watershed carrying lodgepole pine cover is now being selected. Instrumentation will begin in 1966. Research consists of a combination of experimental watershed, broad survey and companion study approaches. A beginning has been made in the latter.

Future development

Recognizing the likelihood of early pulp operation establishment, some initial priority must be given to formulation of qualitative management guidelines. An initial fact-finding phase is necessary, covering the proposed pulp operation area. In water quality, existing erosion hazard study and the proposed model logging operation should assist. Existing erosion damage information, if made available, will also be of major assistance.

This necessary initial emphasis on qualitative management guidelines must quickly yield to the main business of the project, viz., a long-term program in research designed to obtain optimal hydrologic effects through cover manipulation. The main direction of research should be into consumptive use, using various approaches but with energy budget techniques prominent. Research into snow hydrology, though some will be needed, will not be so concentrated as in the spruce-fir forest hydrology project. Combined with consumptive use research will be soil physics study, elucidating the movement of water in the surficial mantle.

Recognition of (and loss assessment in) high transpiration sites, such as those postulated in the early land-vegetation typology study in the Upper Oldman River, should be an important component. The effects of stand age and density should also be closely studied.

Considering the great variability in population(s) under study, the concept of "auxiliary" basins is extremely pertinent here. The same applies to research into "representativeness".

Coal mining and water quality

The small study underway now should be continued to establish definitely the effect of coal mining and associated operations on chemical water quality. Such work is extremely important. The headwaters area contains many coal measures and knowledge obtained now will be beyond price if expanded mining activity begins.

Hydrologic soil classification

This study assesses the adequacy of existing soil classification schemes for hydrologic research purposes. Along with other soils and surficial geology studies, it will provide a base for more detailed future work.

RESEARCH TO BE INITIATED OR GREATLY INTENSIFIED

Research into evapo-transpiration (consumptive use)

Greatly expanded effort is required in this extremely important topic. It is proposed that research utilize integration of skills in meteorology and tree biology. The meteorological research component should concentrate upon energy budget and associated work, while the contribution of the tree biologist can take a number of avenues (e.g. stomatal reaction, water movement in the tree, leaf temperature, albedo variation, etc.) Such work will not only help in understanding hydrologic processes; it will also develop knowledge in tree physiology and autecology.

Such research should be a joint Meteorological Branch-Dept. of Forestry project. It should begin in the Marmot Creek Basin area, but rather quickly move to an orientation towards the lodgepole pine forest hydrology project. Assigned research staff should be a minimum of one meteorologist and one tree biologist, but over long periods would be considerably greater. These studies are of very high priority.

Research into snow hydrology

No intensive research in this high priority area has been done. Studies should be concentrated, initially at least, in the subalpine spruce-fir forest hydrology project. Initial stress should be placed upon determination of snowpack characteristics in different conditions of forest cover, topography, elevation and aspect, upon examination of snowpack metamorphosis, and over-winter and spring evaporative losses.

Eventually some attention may be paid to snow in the alpine zone, but this is believed of relatively minor importance, and to avalanches, but these again are not presently considered of priority.

It is recommended that the Steering Committee contact the Snow and Ice Section, Division of Building Research, National Research Council, to determine whether this group will assign a researcher to this work, perhaps for an initial period of four years. Otherwise, Dept. of Forestry or Meteorological Branch should assume this responsibility. The snow hydrology researcher should work closely with other researchers in forest manipulation and in meteorology. Some work will be required eventually in lodgepole pine forests.

Research into soil water

Knowledge of water movement in the surficial mantle is badly needed. Soil erodibility importance remains to be evaluated, principally by model logging operation, and from surveys of existing damage.

At present, it is believed research in soil water should be concentrated upon movement of water in the mantle, its accretion to groundwater, and its withdrawal by evapo-transpiration. Should the model logging operation show valid and serious sedimentation-erosion problems to exist, this priority would be changed.

Hydrologic soil classification and survey of surficial deposits and soils within the headwaters area have been designed to provide a base for such research. It is recommended that the Dept. of Forestry make available a soil physicist for this research, and that his work be concentrated initially in the lodgepole pine forest hydrology project, preferably to a degree in consumptive use studies.

Research into resource economics

The value of water flowing from the headwaters is recognized but has not been quantified. It is desirable that these waterflows be economically evaluated, to help provide guidelines for management. Commodity resources, being susceptible to economic appraisal, tend at present to supercede water production considerations.

It is recommended that a resource trained economist be assigned the task of appraising the value of waterflows in relation to other resources, particularly commodity resources. Perhaps a participating research agency can make such staff available; otherwise, it might be handled by university contract or by extra-mural grant. The assignment is a very difficult one and the need is not only regional but national.

PROFESSIONAL MANPOWER REQUIREMENTS

Present assigned staff are D. A. Davis (engineering-hydrology), T. Singh (forest hydrology), C. R. Stanton (forest hydrology), D. R. Stevenson (hydrogeology), D. Storr (meteorology), and W. W. Jeffrey (inter-disciplinary co-ordination). In addition, three researchers in agricultural sciences (J. F. Dormaar, A. Johnston, L. E. Lutwick) devote part of their research effort to the program. It is anticipated that a one man, full-time commitment (or equivalent) will be needed in the future in both engineering-hydrology and hydrogeology.

A wildlife biologist and a forest hydrologist (lodgepole pine forest hydrology) will join the program in 1966. In 1967, a specialist in vegetation-water relations (forest hydrology-consumptive use research) and a snow hydrologist should be obtained. In 1968, a soil water specialist (soil physics) should be hired. These needs are minimal.

It is believed likely that two more forest hydrologists, one for foothills spruce forest, the other for lodgepole pine forest hydrology, will also be desirable at a later date. If serious erosion problems are found to exist, another soils specialist will be needed.

Research needs noted in recreation, resource economics, chemical water quality etc., it is presently assumed can be handled by ad hoc arrangements. No assessment is made of short-term specialist or professional advisory assignment requirements.

SUMMATION

The program is moving away from an initial preoccupation with experimental basin selection and instrumentation, into a greater emphasis upon intensive study of hydrologic processes, combined with short-term pragmatic development of qualitative management guidelines. The outlook seems good for a significant, perhaps a very significant, contribution to watershed management, land use hydrology and basic hydrologic understanding in future national progress.

W. W. Jeffrey
Co-ordinator,
February 14, 1966.